

## Dissolved Oxygen and Alberta Streams and Rivers

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### Highlights

- Dissolved oxygen (DO) is very important to the health of aquatic ecosystems.
- Dissolved oxygen is a key indicator in determining water quality.
- Cold water can hold more dissolved oxygen than warm water.
- Several factors influence dissolved oxygen.

### What is dissolved oxygen?

Dissolved oxygen refers to oxygen existing in a “free” or unbound (not part of other compounds) form or state in water or other liquid. The solubility of oxygen is the degree or ease to which oxygen can dissolve in water, wastewater, or other liquid.

Temperature directly affects the solubility of oxygen in water. When the temperature of water increases, a portion of oxygen converts from liquid state to a gas. Thus the ability of water to maintain oxygen in dissolved state decreases with increasing temperature. As a result, colder water can potentially contain more dissolved oxygen than warm water.

Oxygen usually enters a lake or stream at its surface (atmospheric oxygen) and by photosynthesizing aquatic plants, including algae and cyanobacteria.

### What is a dissolved oxygen test?

A dissolved oxygen test provides an indication of the amount oxygen freely available to the aquatic environment.

For the dissolved oxygen test in the Alberta Water Quality Monitoring Day kit, tablets are added to a sample of water. After about 5 minutes the water will change color. The color of the water provides an indication of the amount of dissolved oxygen.

This test is a screening test and will only give ballpark indications of poor, fair, and good water quality. If you want more accurate measurements or need a higher range, you could use a Winkler Titration kit that would be more expensive and require more careful handling.

### What is normal the normal range of dissolved oxygen in rivers and streams in Alberta?

Due to temperature changes or large amounts of plants, algae and cyanobacteria, dissolved oxygen levels can fluctuate throughout the day. This can affect the ability of plants and animals to survive.

Dissolved oxygen can change significantly from day to night.

#### Temp and DO

Cold water can hold more dissolved oxygen than warm water. For example, water at 20 degrees Celsius will be 100% saturated (can not hold any more) with 8 parts per million dissolved oxygen. Water at 8 degrees Celsius can hold up to 12 parts per million of oxygen before it is 100% saturated.

Most rivers and streams should be well oxygenated during the AWQA day sampling as the recent disappearance of ice cover, increased runoff (i.e. higher flows) and lack of decomposing aquatic plants, and algae, occur at this time of the year.

#### **What decreases dissolved oxygen in rivers and streams?**

- Increasing temperature. Warm water can hold less dissolved oxygen.
- High levels of bacteria from sewage pollution.
- Large amounts of rotting plants and algae.
- Industrial and municipal discharges into streams and rivers.

#### **What increases dissolved oxygen in rivers and streams?**

- Decreasing temperature. Cold water can hold more dissolved oxygen.
- High flow rate (how fast the river runs).
- The presence of rapids and steep gradient (induce more complete mixing of the water with atmospheric oxygen)

#### **Why is dissolved oxygen important?**

Dissolved oxygen is important to the health of aquatic ecosystems and is considered to be the most important and commonly employed measurement of water quality. All aquatic animals need oxygen to survive. Natural waters with consistently high dissolved oxygen levels are most likely healthy, stable environments, able to support a wide variety of plants and animals.

Low oxygen concentrations can be damaging to a variety of critical life stages of aquatic animals, including larval invertebrates, and fish eggs and fry. Like temperature, organisms differ in their tolerance to low dissolved oxygen levels. The ideal dissolved oxygen level for fish is between 7 and 9 milligrams per liter (mg/L); most fish cannot survive at levels below 3 mg/L of dissolved oxygen. Alberta Surface Water Quality Guidelines suggest dissolved oxygen concentrations must not decline below 5 mg/L and should not average less than 6.5 mg/L over a seven-day period. However, the guidelines also require that dissolved oxygen concentrations remain above 9.5 mg/L in areas where early life stages of aquatic biota, particularly fish, are present. Anoxic (depleted oxygen) conditions can result in fish kills, which is particularly common during harsh winters with extended ice-cover.

#### **What influences dissolved oxygen in rivers and streams?**

As mentioned above, the amount of oxygen dissolved in a given volume of water is dependent on the **water's temperature**, as temperature affects oxygen solubility. Aside from temperature, other factors can also affect the amount of oxygen dissolved in water.

Atmospheric oxygen enters at the waters' surface. The amount of oxygen mixing with water is dependent on the **speed of flow** in streams and rivers. Compared to fast-flowing rivers and streams, those that are slow flowing will have less oxygen because there is little stirring of atmospheric oxygen into the water. **Winter ice cover** blocks atmospheric oxygen from mixing with surface waters. Lakes and large, slow-flowing rivers with an

**abundance of plants and algae** can have extremely low oxygen concentrations under ice cover due to decomposition, which consumes oxygen.

Aquatic plants produce significant amounts of oxygen during daylight hours. With an increasing abundance of plants, algae and cyanobacteria the greater potential there is for oxygen production. However, there is another side to this story as plants, algae and cyanobacteria respire at the night, which consumes oxygen. Because of this, aquatic ecosystems with an abundance of plant production can have extremely low oxygen concentrations just before dawn. As well, the microbial decomposition of dead plant matter consumes oxygen.

Some industrial and municipal discharges and effluents contain organic compounds that can be degraded by bacteria, which as we know, consumes oxygen. Biological oxygen demand (BOD) measures the amount of biologically degradable material present in organic wastes by determining the amount of oxygen consumed over a period of time through normal biological decomposition. Other discharges and effluents contain non-biodegradable compounds that can chemically bind up or otherwise remove the oxygen from a free state. Chemical oxygen demand (COD) is a measure of the amount of organic substances in water or wastewater with the potential to bind oxygen. Hence, industrial and municipal discharges and effluents can impact the oxygen content of receiving waters with time. Secondary and advanced wastewater treatment techniques are generally designed to ensure adequate dissolved oxygen in waste-receiving waters.